NASA	STUDY OF THE IMPACT OF LONG-TERM SPACE TRAVEL ON THE ASTRONAUT'S MICROBIOME	MICROBIOME

Principal investigator

Hernan Lorenzi

Experiment Description

The goal of the experiment is to determine how the composition of the human microbiome changes during long-term space exploration and to evaluate its potential impact on a crewmember's health. Some microbial species from the human microbiome have a beneficial or protective effect on health; the loss of these species can lead to an altered metabolic function and, in conjunction with reduced immune response, may increase the chance of infection by opportunistic pathogens. This experiment will elaborate the notion of the microbiome as harbingers or sentinels to monitor a variety of aspects of the human host, including associations with health status, environmental stress, and exposure to space conditions. By sampling the microbiome of astronauts on earth while in peak physical health and during subsequent times of stress, including long-term exposure to microgravity, g-forces, radiation and changes in health status, we will be able to define signatures of human response to a variety of relevant aspects of space travel. This experiment will characterize the prokaryotic and viral microbiome from various body sites of up to nine astronauts who travel to space at several time points before, during, and after a space mission. Also, the astronauts' immune function will be assessed before, during, and after the mission by analyzing saliva samples for reactivated latent viruses and cortisol levels as well as cytokines from blood samples. Finally, the microbiome and immune function data collected will be correlated with other measured metadata including astronaut health and hygiene as well as environmental factors(such as temperature, humidity) that will be documented in conjunction with the Microbiome Subject Sampling session.

Objectives

Objective 1: To characterize and investigate the changes occurring in the prokaryotic and viral microbiome of astronauts from key body sites before, during and after a space mission. We will collect and analyze samples of up to nine (9) astronauts from key body sites (2 skin sites, saliva, nares and gut) before, during and after a 6-month space mission (4 time points before and 3 time points during and after the mission).
Objective 2: To assess astronaut immune function before, during, and after the space mission.
We will assess immune function by detecting reactivated viruses in saliva samples and measuring levels of several cytokines in serum before, during and after spaceflight (4 blood time points and 10 saliva time points) to evaluate the state of the astronauts innate (IFN-alpha, IFN-beta) and adaptive (IFN-gamma, IL-2, IL-4, IL-6) immune responses. In addition, we will measure the amount of cortisol in saliva to estimate stress levels. Both, virus reactivation and cortisol are two indicators commonly used during spaceflight immune studies.
Objective 3: To identify associations between changes in the astronaut's microbiome and relevant metadata.
We will investigate the existence of statistically significant correlations between the microbiome DNA sequence data and metadata including astronaut health and hygiene as well as environmental factors such as temperature, humidity, and environmental metagenomic sequencing of samples collected from various surfaces on the ISS.

Relevance

The human microbiome, the collection of microbes that live in and on the human body, plays an important role in human health contributing to the processing and absorption of nutrients in the human body, and/or playing a protective role (for example) by competing for resources with pathogenic organisms. Changes in the dynamic or composition of the human microbiome may lead to altered human metabolic function or pave the way for the colonization of the human body by opportunistic pathogenic microorganisms.
It is known that factors such as stress, diet and an impaired immune system can trigger changes in the human microbiota, increasing the risk of contracting a disease. The product of this study will be an assessment of the likelihood and consequences of alterations in the microbiome, due to extreme environments, and the related human health risk.

BDC Summary

To assess the composition and dynamic of the subjects microbiome, Microbiome Sampling of the forehead skin, left and right forearm, left and right nares, oral cavity and saliva will be collected at 240, 150, 90 and 60 days prior to launch as well as R+1-3, R+30 and R+60 days after return. Approximately 20g stool sample will also be collected during these timeframes. Ten (10) mL of blood will be collected at 60 days prior to launch and again on R+0 to assess the subject's immune function. An Environmental Health and Hygiene survey will be completed in conjunction with each Microbiome Subject sampling session (L-240, L-150, L-90, L-60, R+1-3, R+30 and R+60) to document metadata including astronaut health and hygiene as well as environmental factors such as temperature and humidity. Lastly, a post-flight recovery saliva and blood sample will be collected at R+180 days post-flight.

In-flight Operations Summary

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In-Flight, microbiome samples of the forehead skin, left and right forearm, left and right nares, oral cavity and four saliva samples will be collected at FD7, FD90 and R-14. Stool gauze samples will also be collected during this timeframe (optional). In conjunction with the subject swab/gauze sampling, environmental microbiome sample swabs will be taken from ISS module locations used throughout a normal crew day at FD7 and R-14. Environmental Surface Swab samples will be collected from the crewmembers sleeping quarters, exercise equipment and two air vents located within frequently used ISS modules. The crewmember will also collect a 400mL water sample from the Potable Water Dispenser (PWD). Whole body perspiration collection (utilizing a gauze pad) will take place on FD7 and R-14. Five milliliters of blood will be collected on FD7 and ten milliliters of blood will be collected on R-2. Lastly, an Environmental Health and Hygiene survey will be completed to document metadata including astronaut health and hygiene as well as environmental factors such as temperature and humidity.		
Subject Selection/Participation Criteria		